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UNION
CARBIDE

INTERNAL CORRESPONDENCE

UNION CARBIDE NUCLEAR COMPANY • POST OFFICE BOX P, OAK RIDGE, TENNESSEE

To (Name) Mr. A. L. Allen
Company Mr. A. Varlan
Location

Date June 8, 1959

Copy to Mr. E. C. Bollinger
Mr. J. Dykstra
Mr. A. J. Mallett
Mr. J. A. Parsons ✓
Mr. S. S. Stief
Production Division File
File (2) NoRC

1/31/96
Data

Subject K-1420 Evaporation Test

Memorandum No. 1

The increased interest in processing highly enriched uranium through the K-1420 recovery system stimulated an investigation to determine the quantity of uranium entrained in the condensate from the "individually safe" evaporators (Figure 1) at various evaporation rates. The results would also provide useful data to determine the most economical method of increasing the capacity of the existing drum dryer in the recovery system.

Test data were taken using the following operating technique:

1. The concentration of uranium in the evaporator solution was maintained by charging a known concentration and volume. The volume was held constant by the addition of water during the run to maintain a fixed level of solution in the evaporator loop.
 2. The calandria steam pressure was held constant for each run until all data were taken. It was then increased by five or ten psig for the next run.
 3. The condensate for each run of set steam pressure was monitored until the ppm of uranium content became constant.
 4. The condensate rates were determined by weighing over a fixed period of time.

Data were taken from two evaporators located in the K-1420 recovery area. These evaporators are identified as B-6 and B-4. The design criteria for these evaporators are shown as follows:

Union Carbide Nuclear Company, Oak Ridge Gaseous Diffusion Plant, Operating Contractor for the U.S. Atomic Energy Commission.

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Design Criteria

B-26 Evaporator

Feed Rate	300 lbs./hr.
Vaporization Rate	263 lbs./hr.
Feed Material	Aqueous solution nitric acid and nitrate salts. 70°F.
Feed Temperature	225°F.
Product Properties:	1.283
A. Boiling point	0.83 centipoise at 225°F.
B. Specific gravity	
C. Viscosity	
D. Design temperature difference between boiling solution and heating medium	60°F.
E. Uranium concentration	0.5 gU/liter to 12.5 gU/liter
Heat Load	299,000 BTU/hr.
Operating Pressure	Atmospheric

B-4 Evaporator

Feed Rate	860 lbs./hr.
Vaporization Rate	750 lbs./hr.
Feed Material	Aqueous solution nitric acid and nitrate salts. 70°F.
Feed Temperature	Varies from 0.5 gU/liter to 1 gU/liter.
Product Properties:	225°F.
A. Uranium concentration	1.283
B. Boiling point	0.83 centipoise at 225°F.
C. Specific gravity	
D. Viscosity	
E. Design temperature difference between boiling solution and heating medium	60°F.
Heat Load	854,000 BTU/hr.
Operating Pressure	Atmospheric

The conclusions drawn thus far are presented:

1. As the evaporator solution uranium concentration increases and the evaporation rate increases, the loss of uranium to the condensate increases. To obtain condensate containing less than ten parts per million of uranium with the existing system, the evaporation rate must decrease as the evaporator solution concentration increases. See Curves 1, 2, 3, and 4.

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2. The heat transfer characteristics of the calandria decrease as the uranium concentration in the product solution increases and a higher steam pressure is required to maintain the same heat input. See Curve 5. (The film resistance inside the tubes increases and the temperature difference must increase to maintain the same heat input.)
3. The efficiency of the mist entrainment separators must be increased by redesign of the existing internal mist separator. See figure 2. At present two proposals are being investigated:
 - A. The installation of a battery of 24 sintered stainless steel tubes. See figure 3. This unit was designed by the General Engineering Department.
 - B. The installation of a York mesh demister.
- Further test runs will be made when A. above is completed.
4. The primary evaporator (B-4) can be operated at the design evaporation rate of 90 gallons per hour with a product solution concentration of four grams of uranium per liter or less to obtain a condensate containing ten ppm or less of uranium.
An evaporation rate of 140 gallons per hour is possible with a product solution concentration of four grams per liter. At this condition, the condensate will contain approximately 80 ppm of uranium. See Curve 4.
5. The design capacity (32 gal./hr.) of the pre-evaporator (B-26B) can be exceeded with a condensate contamination of less than ten ppm of uranium. Under existing conditions, the unit can be operated as listed below and as shown on Curve 3.

Maximum Evaporation Rate With Less
Than 10 ppm Uranium Loss in Condensate

Evaporation Rate Gals./Hour	Product Solution Concentration, Gm.U/Liter	Calandria Stream Pressure, psig
14	300	30
18	219	30
21	100	15
29	67.75	15
43	20	20
72	8.6	
32	12.5 (design capacity)	

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6. The capacity of the drum dryer-calciner system must be increased. It is recommended that the diameter of the drum be increased from 6 to 18 inches in order to change the capacity from 4.05 to 10.5 pounds per hour of UNH. The other operating conditions of 9.5 rpm, 24 psig steam pressure and feed solution concentration of 300 grams U per liter should remain unchanged. This proposal has been reviewed by Mr. W. A. Pryor of the Nuclear Safety Section, and ESO M-25655 has been initiated. The above proposal can be completed for less than \$5,000.

R.J. Clouse
R. J. Clouse

R. Paluzelle
R. Paluzelle

RJC:RP/jc

Attachments

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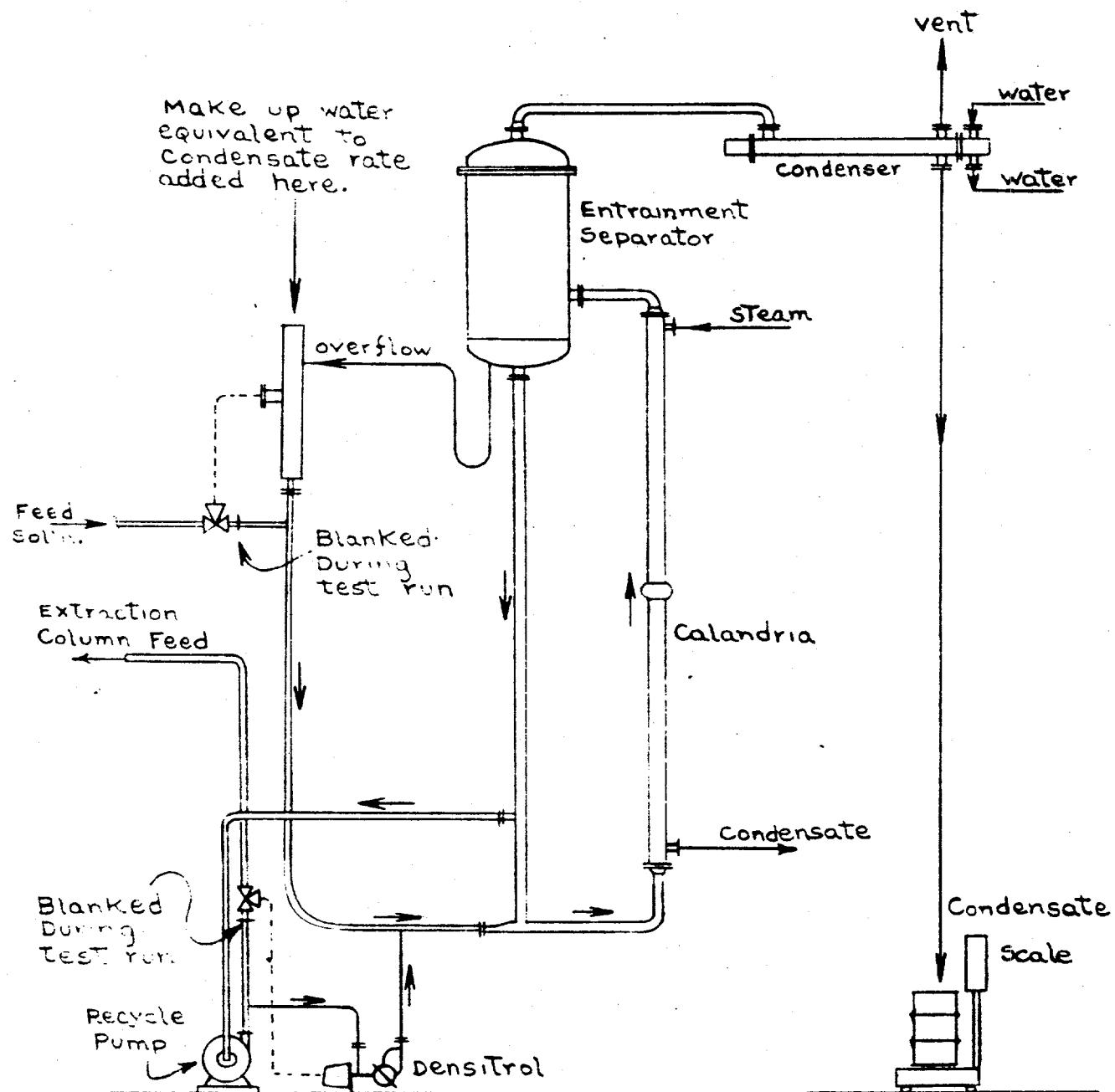
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Evaporator System

Figure 1



System Identical For B-4 and B-26

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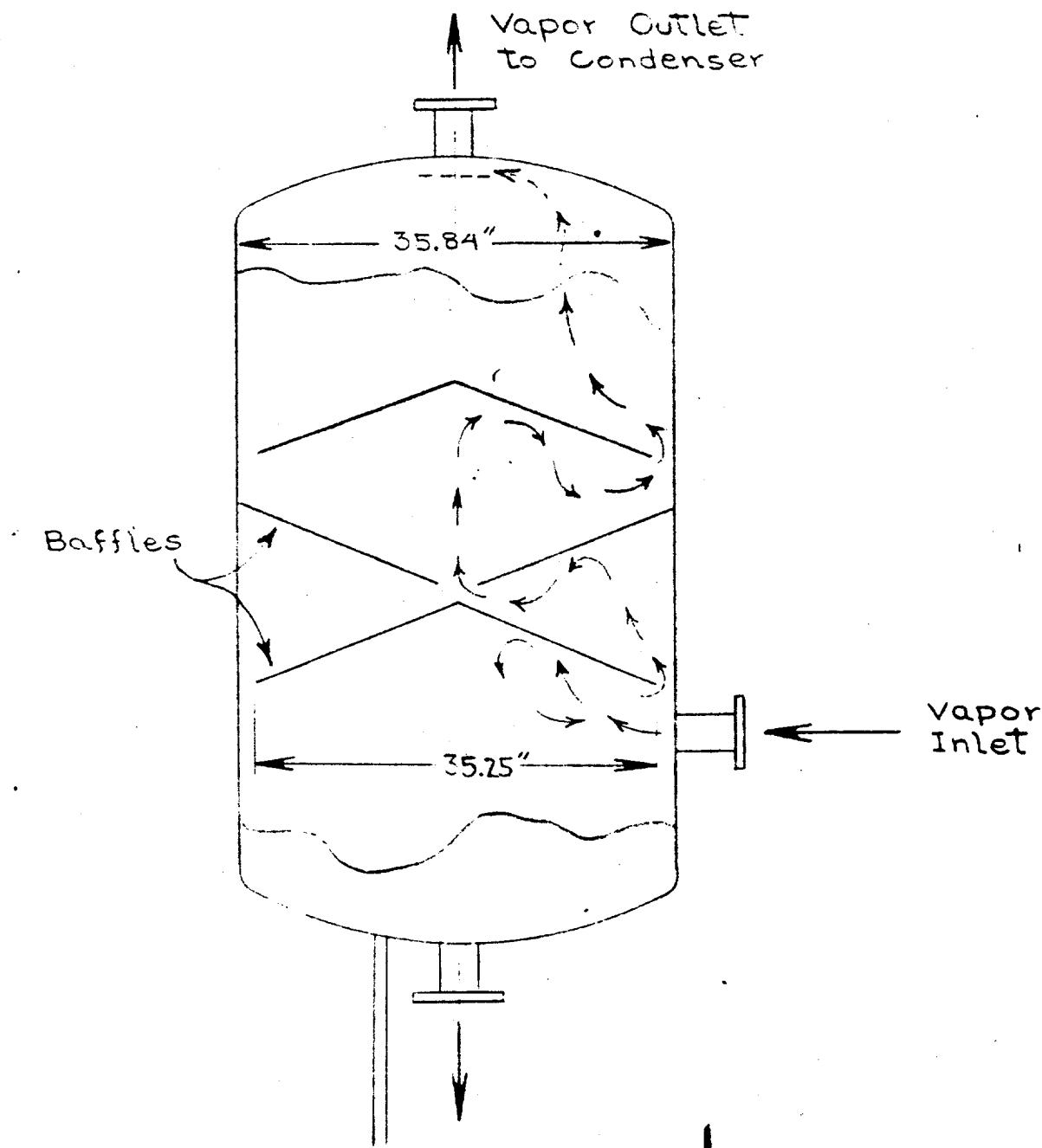
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Mist Entrainment Separator of Primary
B-4 Evaporator During Test Runs

Figure 2



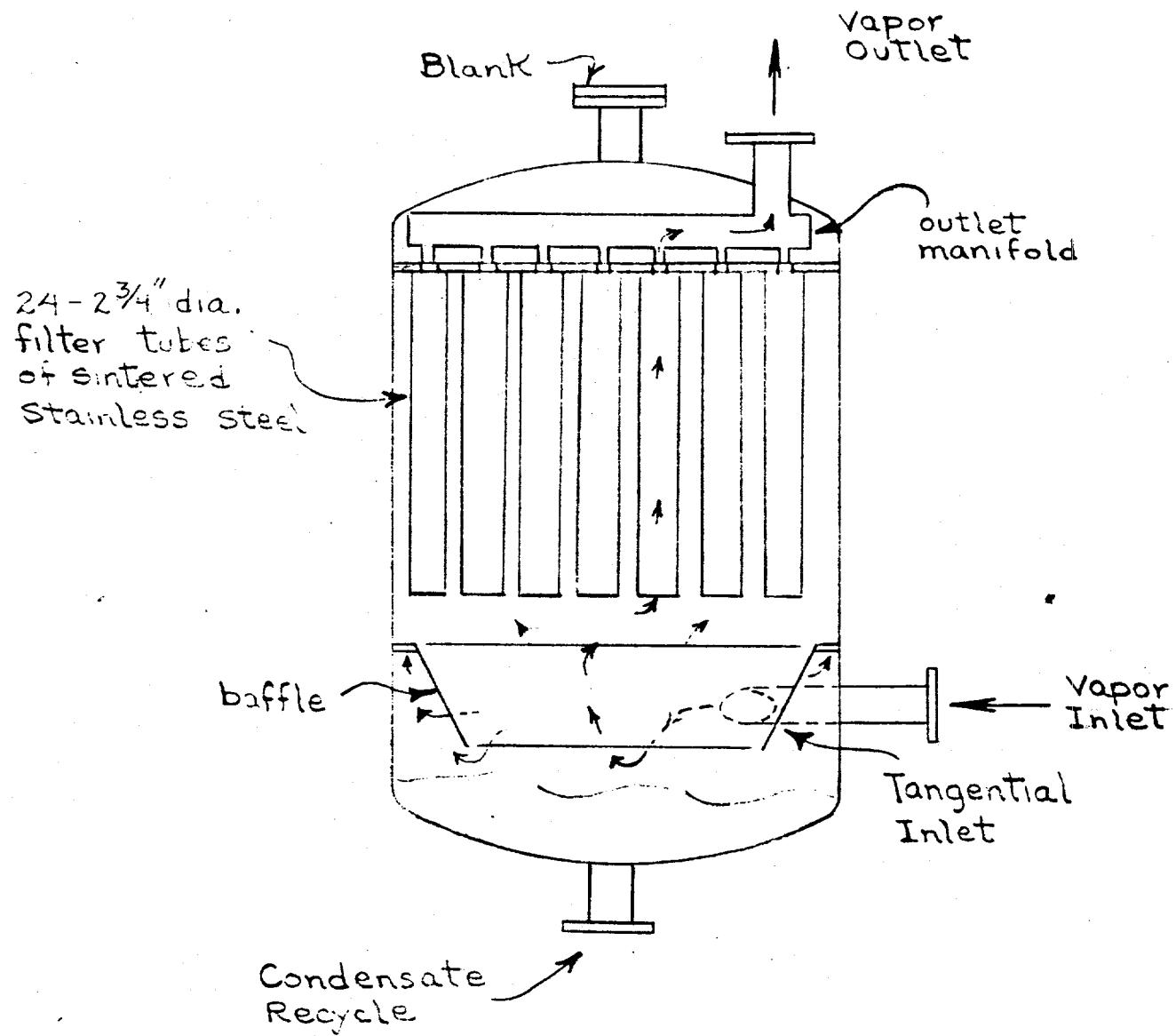
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Modified Mist ~~Environment~~ Separator
For The B-4 Evaporator

Figure 3



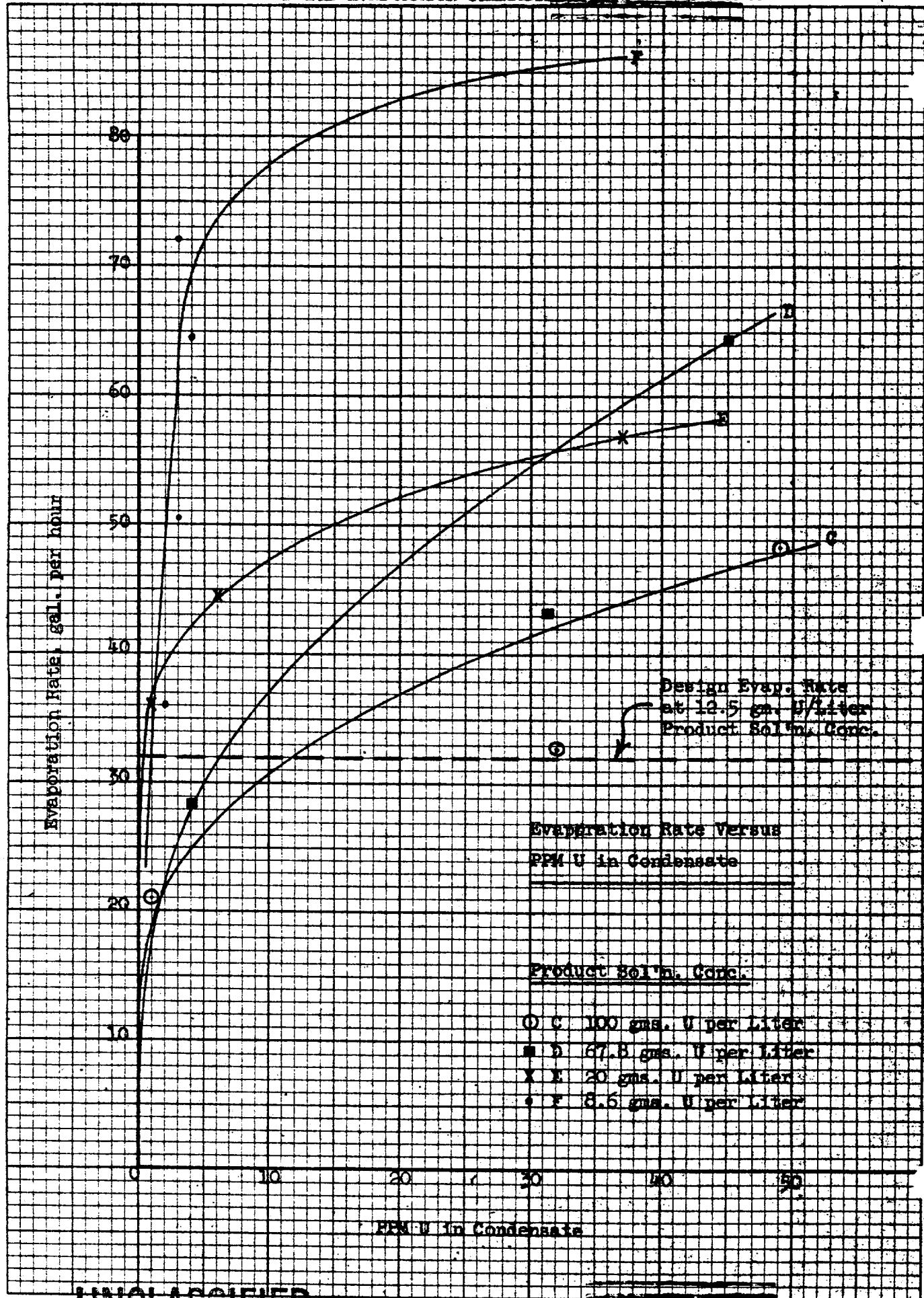
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B-26B EVAPORATOR CHARACTERISTICS

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EUGENE DIETZGEN CO.
MADE IN U. S. A.

NO. 340 10 DIETZGEN GRAPH PAPER
10 X 10 PER INCH

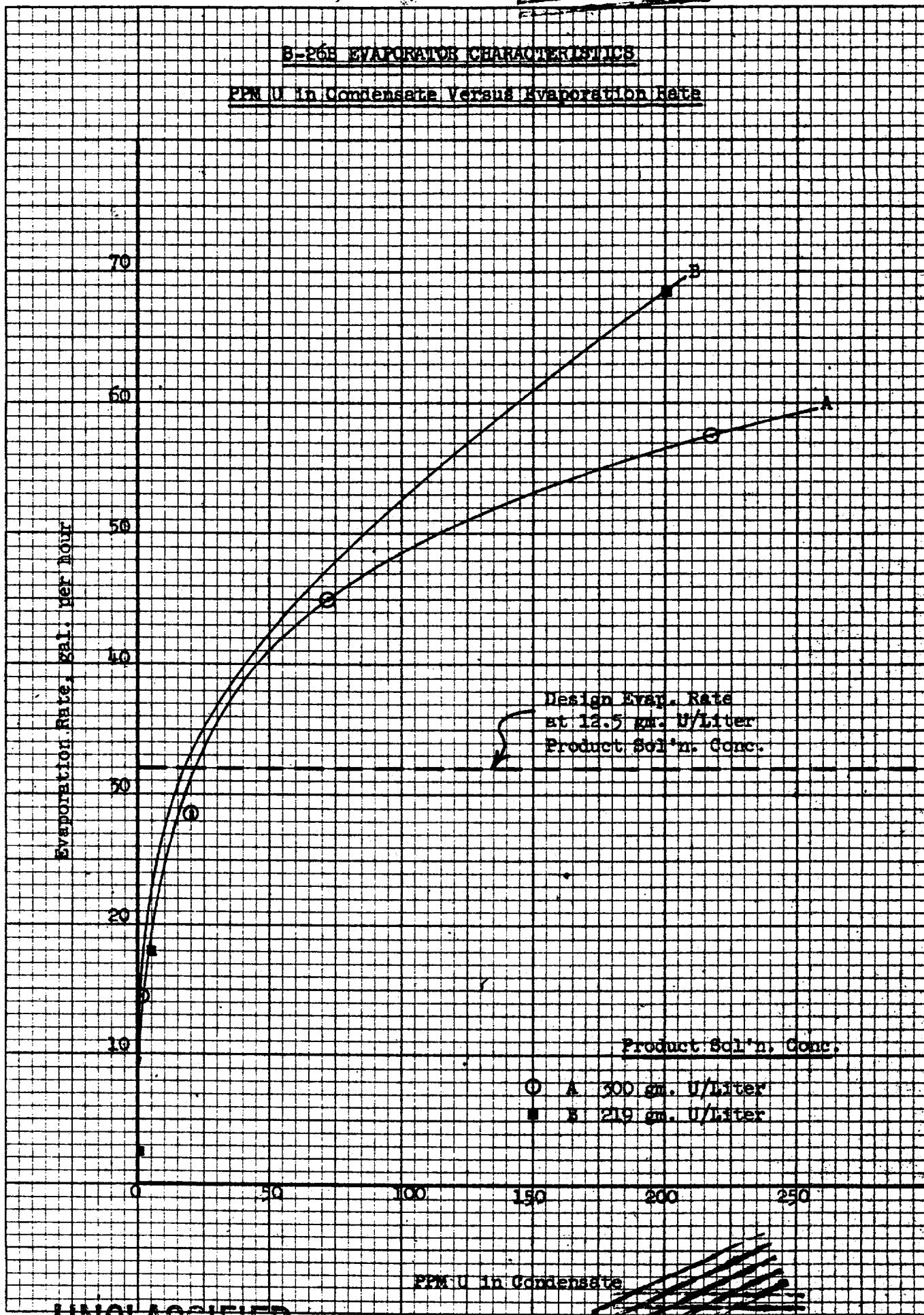
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B-265 EVAPORATOR CHARACTERISTICS

PPM U in Condensate Versus Evaporation Rate

EUGENE DIETZGEN CO.
MADE IN U. S. A.

NO. 340 10 X 10 PER INCH
10 DIETZGEN GRAPH PAPER



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Curve 2

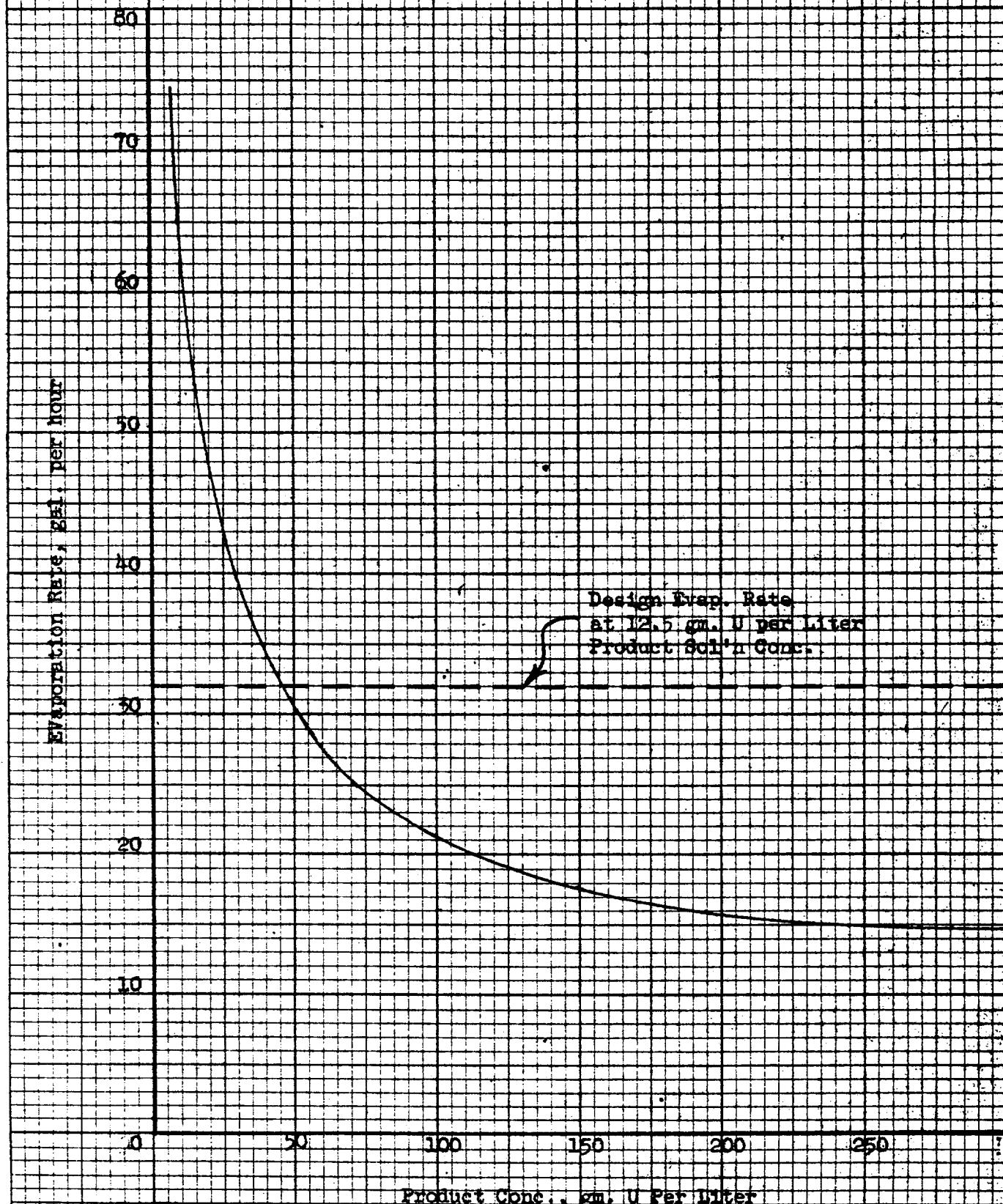
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B-26B EVAPORATOR CHARACTERISTICS

Product Concentration Versus Evaporation Rate for Less Than 10 PPM U in Condensate



EUGENE DIETZGEN CO.
MADE IN U. S. A.

NO. 340 10x10 GRAPH PAPER
10X10 PER INCH

Product Conc., gm. U Per Liter

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Curve 3

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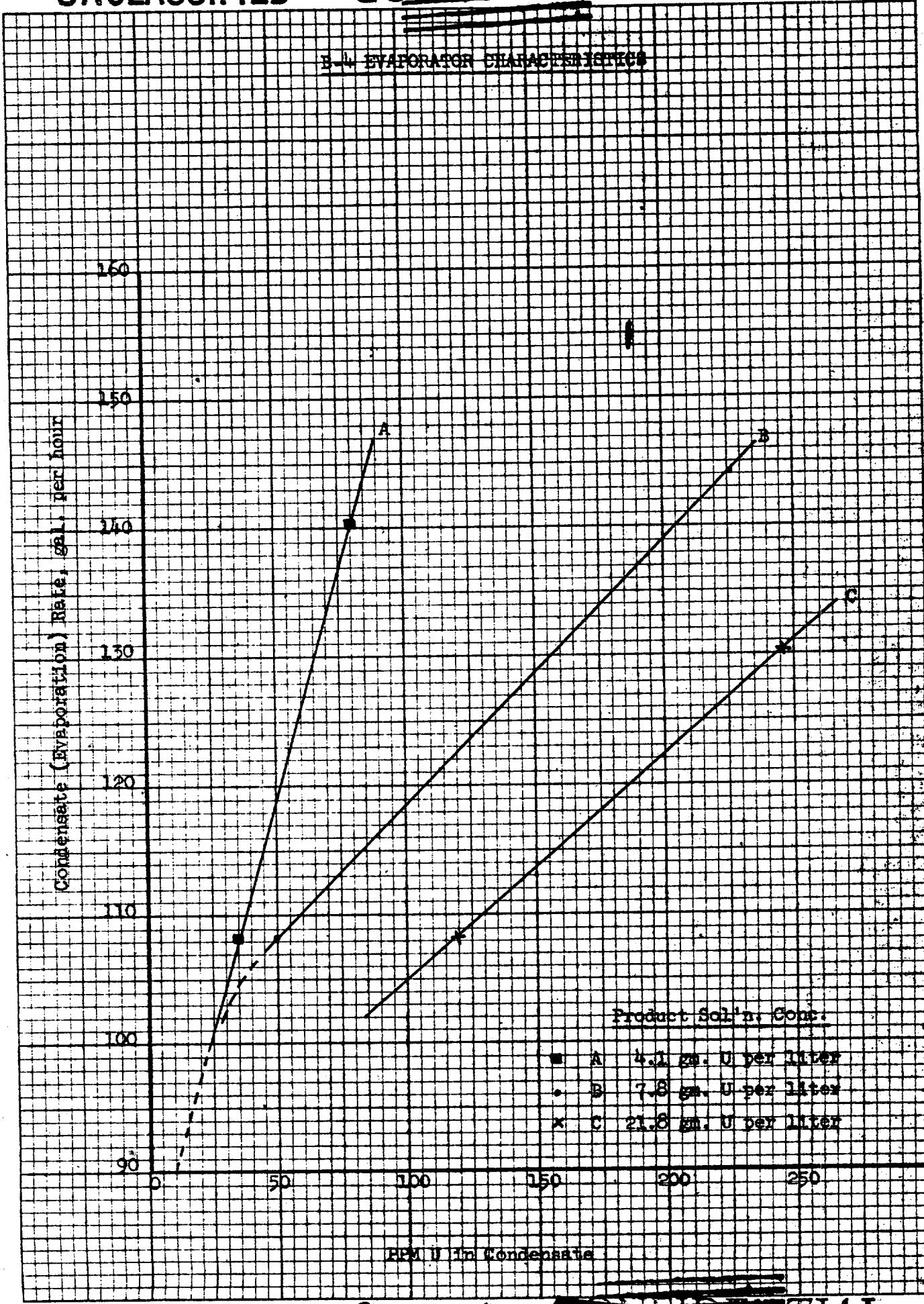
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B-4 EVAPORATOR CHARACTERISTICS

EUGENE DIETZGEN CO.
MADE IN U. S. A.

NO. 340 10 X 10 DIETZGEN GRAPH PAPER
10 X 10 PER INCH



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B-26E EVAPORATOR CHARACTERISTICS
Steam Pressure Versus Condensate Rate

EUGENE DIETZGEN CO.
MADE IN U. S. A.

NO. 340 10x10 DIETZGEN GRAPH PAPER
10x10 PER INCH

